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ANNUAL REPORT OF THE GORGAS MEMORIAL LABORATORY, 1938

LETTER

FROM

THE GORGAS MEMORIAL INSTITUTE

TRANSMITTING

THE REPORT OF THE GORGAS MEMORIAL LABORATORY FOR THE FISCAL YEAR ENDED JUNE 30, 1938

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LETTER OF TRANSMITTAL

GORGAS MEMORIAL INSTITUTE OF
TROPICAL AND PREVENTIVE MEDICINE, INC.,
Washington, D. C., December 31, 1938.

Hon. WILLIAM B. BANKHEAD,
Speaker of the House of Representatives,
Washington, D. C.

SIR: I have the honor to transmit herewith the report of the Gorgas Memorial Laboratory for the fiscal year ended June 30, 1938. This is in accordance with the act of Congress approved May 7, 1928, and the provision embodied in the appropriation act approved April 27, 1938.

Respectfully,

GEORGE CRILE,
President, Gorgas Memorial Institute of Tropical and Preventive Medicine, Inc.

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GORGAS MEMORIAL INSTITUTE OF
TROPICAL AND PREVENTIVE MEDICINE, INC.,
Washington, D. C., December 31, 1938.

To the Members of the Senate and the House of Representatives of the United States.

SIRS: In accordance with section 3 of the act of Congress approved May 7, 1928, and the provision embodied in the appropriation act approved April 27, 1938, we have the honor to submit on behalf of the Gorgas Memorial Institute of Tropical and Preventive Medicine, Inc., the report of the work and operation of the Gorgas Memorial Laboratory for the fiscal year ended June 30, 1938.

This is the eleventh such report to be submitted.

SCIENTIFIC ORGANIZATION

The permanent staff of the laboratory consists of four members: A protozoologist, a helminthologist, a medical entomologist, and a director who adds to his administrative duties a large share of the field study in malaria problems, veterinary problems, and the pathological service of the laboratory.

In addition to the permanent staff, scientific men have been on tour of duty detailed by their own organizations to investigate problems for which the laboratory can assemble the material needed for study. The United States Public Health Service has extended the detail of an officer who is a very capable entomologist and sanitary inspector. The Medical Corps of the United States Navy has an officer and two technicians assigned to study diagnosis and treatment of human carriers of pathogenic amoebae.

A third group of workers who are listed as visiting scientists have been at the laboratory from time to time to collect material and pursue certain studies connected with their problems that could only be carried on in some part of the Tropics. Details concerning these workers will be found later in this report under the heading of "visiting scientists."

WORKING CENTERS

The laboratory has four centers: The Gorgas Memorial Laboratory at No. 68 Avenida Justo Arosemena, Panama, Republic of Panama; the Miraflores Veterinary Station on the shore of Miraflores Lake, west of the Miraflores locks of the Panama Canal; the Santa Rosa Malaria Control Station on the banks of the Chagres River near the eastern boundary of the Canal Zone; and the Juan Mina Entomo-

logical Station, a new station on the Chagres River just inside the Canal Zone boundary.

In addition to these established working centers further support in assembling material is gained by making expeditions into the interior of the Republic of Panama where suitable material can be found. One malaria inspection trip was made to the Santa Maria Timber Co.'s holding on the coast about 220 miles west of Panama City, and another was made into the Darien Province of Panama on the survey of two or three diseases in the tidewater towns of the Tuira River. Another trip of 2 months' duration was made by the director into the thoroughbred-horse centers of Virginia and Kentucky to further stimulate the study of periodic ophthalmia and organize research centers for the sustained investigations of this and other domestic-animal diseases.

MAINTENANCE AND REPAIRS

The Gorgas Memorial Laboratory and its animal house and insectary were reconditioned, redecorated, and painted. Many of the animal cages were rebuilt due to dry rot and termite action. Venetian blinds were installed in five rooms. The second largest item was the reconditioning, painting, and screening of the cottage now serving us as Juan Mina Entomological Station. The Miraflores Veterinary Station has had a change made in its lake dock. The shed covering this dock was so nearly destroyed by termites that repairs had to be made. There being no need for the heavy-timbered shed and roof which had to be anchored by cables to the bank, only the floor was repaired and the steel roofing was used to build a shelter for the motor boat at one end of the dock. Cable supports are no longer needed. Breeding pens were built for the rat-and-mice colony and for the rabbits. The Ford station wagon will be turned in for a new model before the close of the calendar year.

SANTA ROSA MALARIA CONTROL STATION

This station includes six villages: Santa Rosa, Guayabalito, Gatuncillo, Las Guacas, Agua Clara, and New San Juan. The first three lie on the north bank of the Chagres River between the eastern boundary of the Canal Zone and the Madden Dam. The fourth one is opposite Santa Rosa on the south bank of the river. Agua Clara lies about 2 miles behind Santa Rosa on a collection of hills. It is closer to an arm of Gatun Lake than the Chagres River although the small Agua Clara, a branch of the Chagres, drains the town site of Agua Clara. It has communication with the outside by two trails. One leads to Santa Rosa and the other through the Canal Zone to an arm of Gatun Lake. New San Juan is located on the Gatuncillo branch of the Chagres River about 2 miles behind the town of Gatuncillo. New San Juan has a permanent inhabitance of a little over 300 and the other five towns have a total of about 375.

Santa Rosa, Guayabalito, Gatuncillo, Las Guacas, and Agua Clara are so close together and near the same mosquito-breeding area that they have been included in one experiment. The synthetic drugs atebrin and plasmochin are being used in a drug-control experiment without fighting mosquito development and without screening the people. These people are given a microscopic examination by the thick-blood-film method and those who are found positive are treated

with atebrina 0.1 gram three times a day for 5 days and then followed with plasmoquina (simple) 0.01 gram twice a day for 5 days. At the end of this course of treatment everyone is again inspected and all sick from any cause are examined again by the thick-blood-film method. New San Juan is managed in the same way except that this town is not inspected between monthly surveys and it is given a different course of treatment. Here 15 grains of quinine sulphate, in tablet form, are given each day for 5 days and this is followed by plasmoquina (simple) for 5 days just as in the other towns. A native supervisor and six native girls have been trained to assist in treating these towns.

Nine years ago, these people had a malaria parasite index of 45.6 percent. The atebrina-plasmoquina towns this year averaged a monthly parasite index of 6.7 percent and the quinine sulphate-plasmoquina town 6.6 percent. There has been a slow but constant fall year by year following the use of this method and the education of the people who improve steadily in their cooperation. Clinical malaria has decreased almost to the vanishing point but we very well know that the human-seed-bed has not been eradicated. During the year 53 babies under 12 months of age have only revealed one with malaria so that transmission must be very low in these areas in spite of the transient character of a fraction of the population in each village.

The group of people living along the Madden Dam Highway, which was formerly used as a control group, proved to be so transient that its use as a control group was discontinued. One survey of school children in that area was made by the thick-blood-film method. Of 287 children examined, 47 or 16.4 percent were found positive. A few studies have been made to check on what has been happening in similar locations elsewhere in Panama. At the Santa Maria Timber Co., 220 miles west of Panama City, 338 persons were examined and 109 of them, or 32.2 percent, were found positive. A survey was made of six Tuira River villages in the Province of Darien, next to Colombia, in a location similar to that of the Chagres River villages. A total of 496 people were examined and of that number 108, or 21.8 percent were positive. Clinical cases of malaria were common among these people where blood films were positive for parasites.

Experience has been equally good with quinine or atebrina provided the same degree of attention is given the administration of the two drugs. When people are left to the voluntary use of the drugs, they prefer atebrina. The disturbing feature in our work is the number of relapses that occur under any form of treatment. Success has been much greater in decreasing the human-seed-bed of malaria than the mosquito index for malaria in spite of the fact that all positives receive a 5-day course of plasmoquina. Another fact equally hard to explain is the acute attack of malaria in a man of middle age whose blood has been negative for parasites on all surveys for 8 years until June of this year. He lives with his wife and five children, all of whom have had from one to several attacks. This man has spent his life in this river valley.

Santa Rosa Station serves for rural group surveys on other diseases than malaria as previous publications will show. This year a new feature has been added, the study of native diets. Observations will be made over both the dry and rainy seasons by Dr. George Cowgill of Yale University.

MIRAFLORES VETERINARY STATION

The work in progress at the Miraflores Veterinary Station during this past year covers two phases, research and the raising of laboratory animals. The research problem in progress throughout the year has been limited to studies concerning *Strongylus vulgaris*, an equine parasite that damages the mesenteric artery of horses and mules. This parasite is considered a very important subject for study wherever the horse and mule is in use. It is necessary to raise animals for laboratory use and Miraflores provides very important service in this line. At present there are at the station 1,100 guinea pigs, 225 white rats, 125 white mice, and 11 white rabbits.

JUAN MINA ENTOMOLOGICAL STATION

The Juan Mina Entomological Station is a new station just being put into operation. The Panama Canal has given the laboratory permission to recondition an old cottage and make it safe for use as working and living quarters for field workers. Juan Mina lies just inside the Canal Zone boundary and is well located to serve all the villages of the Santa Rosa Station. The station is located in an old orange grove on the opposite side of the Chagres River from the town of Santa Rosa. The building has two bedrooms, a dining room, a long porch, a kitchen, pantry, shower bath, and closet. Half of the space will be made into laboratory rooms. Screening and the installation of a kerosene refrigerator and a kerosene stove for cooking will make it possible and safe to live as well as work in the cottage instead of making the trip from Panama each day, a trip which consumes an hour and a quarter each way. This station will make fine headquarters for any problems studied in the Santa Rosa group of towns whether by the permanent or the visiting staff.

DEPARTMENT OF MEDICAL ENTOMOLOGY

Work in the department of medical entomology was discontinued for a few months following the resignation of Dr. Lloyd E. Rozeboom on September 30, 1937. Dr. Rozeboom joined the staff of the Agricultural Experiment Station of Oklahoma University at Stillwater, Okla. Dr. Daniel M. Jobbins will assume the duties of this department on July 1, 1938. Dr. Jobbins has been research assistant in the Agricultural Experiment Station of the State of New Jersey with headquarters at New Brunswick. On October 1, 1938, a second medical entomologist will appear for duty in this department, Dr. Graham Bell Fairchild, who has just completed postgraduate work at Harvard. With the addition of these new staff members and the new Juan Mina Entomological Station in the midbasin of the Chagres River we anticipate some very interesting field and village studies.

A more extensive study of house catches of mosquitoes and outdoor resting places for Anopheline species can now be carried out and a detailed study of breeding and nonbreeding water areas will be started. Some Anopheline flight observations also will be started in the arm of the lake and river near the villages. Dr. Rozeboom's colony of *Anopheles albimanus* is still being maintained in the insectary at the city laboratory.

DEPARTMENT OF PROTOZOOLOGY

Dr. Carl M. Johnson has continued in charge of the department of protozoology. The year's work, although somewhat diversified, fell into two rather general divisions, one a study of the serological reactions of parasites, particularly with reference to the complement fixation reaction, and the other a general inquiry into the pathogenesis and pathological manifestations of certain protozoan and helminth parasites.

The major problem was a study of the complement fixation test in malaria. This investigation was undertaken principally with the view to establishing a reliable method for determining the efficacy of the various treatments and as a possible approach to the study of relapse in malaria. As with other infections the principal difficulty has been in obtaining a suitable antigen. Since the malarial organism is exclusively an intracellular form it has been difficult to obtain enough of the parasites free from host protein to prepare a good antigen. In general the antigens have been prepared from heavily infected blood of human and monkey hosts. Heavy infections in monkeys were obtained by removing the spleen of the animals before infecting them. The most satisfactory antigen was prepared from heavily infected blood which was collected into a citrate solution, centrifuged to separate the cells from the serum and then washed several times in saline solution. The packed cells were treated with distilled water to liberate the parasites which were later washed a number of times and finally suspended in a 50 percent glycerin and saline solution. With this method of preparation the resulting antigen is almost free of hemoglobin which is of some advantage in reading the tests and in addition seems to be of lower anticomplementary power. Although there has not been opportunity to test large series of sera, the test has been negative in all cases where the sources of the sera were individuals who had never suffered from malaria and monkeys in which previous infections had been ruled out by the application of various laboratory tests. Of 19 sera from individuals residing in highly malarious districts and showing no parasites in thick films 11 were positive in the test and 8 were negative. Of 35 individuals with positive blood films 28 were positive and 7 were negative. Ten positive monkey sera were all positive in the test. There seems to be no specificity between the various species of parasites as shown by the fact that with a monkey antigen it has been possible to demonstrate the presence of complement-fixing antibodies in the sera of patients suffering from all three species of malaria, and vice versa, with antigens prepared from human quartan malaria fixation occurs in monkey malaria. At present the work indicates that with certain refinements in the tests, particularly with respect to the antigen, the complement fixation reaction will be of definite value in detecting the presence of the malarial parasite in its animal hosts.

Further work on the specificity of the complement fixation reaction for Chagas' disease has been carried out. The laboratory staff was fortunate in being able to obtain serum from several cases of cutaneous leishmaniasis. These cases had active lesions in which the parasites were demonstrated by microscopical examination. The sera of

these patients, however, were negative when tested with a "Chagas" antigen. Failure to establish cultures from these cases defeated plans to make antigens to test against known positive "Chagas" sera. It is hoped that this will be possible in the near future. The survey work in Chagas' disease, employing the complement fixation reaction, has continued and the total number of individuals who have been tested now stands at about 1,700. Two new groups in Darien, from Boca de Cupe and the Pirre River, were surveyed this year. No cases of the disease were encountered in these groups. However, during the year's malaria survey work in the Chagres River villages two new cases were found by direct microscopic examination of blood films. This brings the number of positive cases to 62.

As a preliminary to some work to be jointly carried out by the Army Medical Research Board and this department on the serology of filariasis, a number of human sera were turned over to the Board for a preliminary study of the complement fixation reaction in this disease.

The department has for the last year cooperated with the Navy unit under the direction of Dr. J. J. Sapero. From this work one paper has been completed for publication and concerns the incidence of intestinal parasites, more particularly *Endamoeba histolytica*, in naval personnel. This group has also served for an investigation of certain aspects of the transmission of amoebiasis, a problem which at the present time is causing widespread interest. This transmission study is to be incorporated in a second paper which at the present time is in the process of preparation.

Recently from a study of material obtained during a spontaneous epidemic of amoebiasis in the laboratory colony of monkeys evidence was collected which is considered of sufficient importance to open again the question of the genesis of the intestinal lesions in this disease. The present study has so far borne out previous conclusions that the lesions of intestinal amoebiasis are initiated by the amoebae mechanically, and not by a cytolysin elaborated by them. The material collected at the laboratory shows clearly this method of penetration by the parasites.

In cooperation with the department of helminthology the studies initiated last year concerning the pathology of some of the more important worm diseases of animals have been continued and some progress can be reported. A study of the lesions produced by *Protospirura muricola* in the white face monkey was carried out and the findings are incorporated in a written report concerning the identity, and life cycle of the parasite.

DEPARTMENT OF HELMINTHOLOGY

The department of helminthology has continued under the direction of Dr. A. O. Foster. The activities of the current year are summarized under two headings, one covering the studies upon the verminous diseases of equines and the other embracing collateral studies.

In the studies on worm diseases of equines the objective of the current year has been to round out and complete, insofar as possible, the projects outlined in the last annual report. Cooperating with the department of protozoology studies have been made upon the pathology and pathogenesis of some of the more important verminous lesions,

particularly verminous aneurysm. It is believed that this condition, and the others which will be referred to presently, represent pathologic entities although they have not been adequately defined as such in the literature. Recently, two questions have arisen in connection with the histopathologic studies of verminous arteritis which must be solved before the condition can be satisfactorily described. The first concerns the possibility that some preexistent pathologic condition, affecting mainly the intima of the common trunk of the anterior mesenteric artery, may predispose to verminous infestation at this site. The second question concerns the mode of entry of *Strongylus vulgaris* larvae into the vessel. A satisfactory approach to the problem of control rests to a large extent upon the solutions to these questions.

Some attention has been given also to a study of the occurrence and pathology of parasitic gastritis in equines. Two helminths are involved as principal agents in this condition, *Trichostrongylus axei* and *Draschia megastoma*. The former produces thickening and ulceration of the glandular mucosa and the latter produces tumor-like abscesses. It is of interest to note that the observations on local equines have indicated that trichostrongyliasis affects horses which are raised in intimate contact with cattle, from which they apparently derive their infections, while the latter condition appears to affect mainly the race horses of the Juan Franco Jockey Club. During the current year three new cases of trichostrongylus infection have been encountered by the staff at autopsy, bringing the number of these cases to 11. During this period also the total number of autopsies of horses and mules have been increased to 259.

Another pathologic condition which will be studied in conjunction with those already mentioned is what previously has been referred to as a "junction disease," caused by a tapeworm, *Anoplocephala perfoliata*, and affecting the cecal opening of the ileum. Satisfactory material for this study has already been collected.

The study of the eggs of the various strongylid species is being continued and it appears that there are sufficient variations in size and structure to permit a generic diagnosis of infection. It is apparent, however, that, before this method of diagnosis can be made practicable a considerably greater body of data must be accumulated.

A second shipment of parasites from native horses of the Hawaiian Islands was received and identified early this year. As this marks the arbitrary completion of this work, the results may be summarized as follows: A total of 29 species of endoparasites were shown to have established themselves in equines on the islands. These represented 1 liver fluke (*Fasciola gigantica*, not hitherto reported from equines), 1 tapeworm (*Anoplocephala perfoliata*, the most injurious of the equine cestodes), 19 strongyles, of which *Strongylus vulgaris*, the causative agent of verminous arteritis, was the most frequently occurring, 6 extra-strongylid helminthis species, and 2 species of "bots." These findings demonstrate that the parasitic infestations of equines in Hawaii are of considerable economic importance and that the present conditions on the islands are favorable to the establishment and perpetuation of most of the equine species. The data also add to the recorded knowledge of the geographical distribution of the species encountered.

In its collateral studies as in previous years, this department has continued its interest in the verminous aspects of the routine labora-

tory autopsies of wild and domestic animals and in the collection and identification of parasites of domestic animals which become available on the outside. As a result, the helminthology collection has increased during the current year from some 530 different types of specimens to 638 at the time of this writing. This increase means that about every third or fourth day, on the average, the staff has encountered either a new helminth for this locality or a new host-record for a previously collected species. This work has been pursued in the belief that in this way there can be developed a reasonably thorough knowledge of the helminthic fauna of Panama, an objective which is considered as important as a knowledge of the mammals, birds, or fishes.

Perhaps the most important additions to the laboratory's collection are the economically important parasites of domestic animals in Panama. In addition to the parasites of equines, which have been reported upon previously, the staff has collected considerable information upon the species which are important locally in swine, cattle, sheep, goats, dogs, cats, and poultry. To date, some 47 different helminths have been encountered in these hosts.

Probably next in importance are the observations which it has been possible to make upon the parasites and parasitic diseases of captive wild animals. Of particular interest this year was the finding of two cases of heavy infestation with *Capillaria hepatica* ova in the livers of red spider monkeys, *Ateles geoffroyi*. *C. hepatica* is normally a parasite of rodents but has been found once in man. Also, ova of this parasite have been found about 25 times in the feces of man during surveys conducted by this laboratory upon the intestinal parasites of the inhabitants of the Chagres River villages. The pathology and biology of this condition are being studied in cooperation with the department of protozoology. Another condition of importance is a filarial disease affecting captive snakes. During the past year it has seemed increasingly evident that bushmasters and fer-de-lance acquire much heavier filarial infections under captive conditions than in their natural environment, and in several instances during the past year the deaths of the snakes have been attributed to filariasis. The parasite concerned is closely related to, but different from, *Hamatospiculum onchocercum* (Chitwood, 1932) Wehr, 1935. The circumstances indicate the necessity of investigating the possible role of ticks as intermediate hosts and if these are incriminated it will not be difficult to control the infection under laboratory conditions.

During the last year *Protospirura muricola* infection caused, or contributed to, the deaths of many white-face monkeys of the laboratory colony. Present evidence indicates that this parasite is transmitted by cockroaches. In some instances a single cockroach has been observed to harbor over 50 cysts, each containing a larva of P. *muricola*, while in monkeys one frequently observes a thousand or more of these worms. Experimentally the opossum is a readily susceptible host for this species, and, since rodents are the normal hosts, it must be concluded that *P. muricola* shows a remarkable adaptability to a wide variety of hosts.

Because of the availability of material and for reasons outlined in the last annual report, a study was made this year of the helminth parasites occurring in the Panama woolly opossum, *Philander laniger pallidus* Thomas. Among these parasites were two liver flukes, a

whipworm, a pinworm, and a filaria, which are new to science. Their descriptions will be published during the coming year.

In August of this year a paper was prepared on "Factors affecting the egg-worm ratio in hookworm infection" for presentation at the meeting for that month of the Medical Association of the Isthmian Canal Zone. The thesis of this paper was that dilution of egg counts are not a measure of infestations in individual cases and are of questionable value for determining the levels of infestation in population groups. Because of the bearing of this matter upon the public health approach to the hookworm problem, it is intended to review this matter further with an aim to developing a better approach to the control of hookworm disease.

In response to a request from Prof. G. Witenberg of the Hebrew University, Palestine, for specimens of Acanthocephala from Central American mammals, the department was able to cooperate to the extent of forwarding to him on August 22, 1938, some 25 vials of specimens from 22 different hosts. It is expected that Professor Witenberg's cooperation wil bring this phase of the work of the department up to date.

PERSONNEL ON TOUR OF DUTY

W. H. W. Komp, senior sanitary engineer, United States Public Health Service, has continued his tour of duty with the laboratory staff, which began in 1931. As before, he remains as a consultant in the experimental studies of drug control of malaria in the Chagres River villages in Panama. His entomological studies have been continued, and an effort has been made to make his laboratory a clearing house of information concerning the identification of mosquitoes from the American Tropics. In this attempt, cooperation has been extended to the departments of malaria control of the Republic of Panama, Costa Rica, Guatemala, and Venezuela, as well as to the Rockefeller Foundation staff working in Colombia on yellow fever. In addition, all the collections made during the study of the mosquito fauna in Ecuador by Dr. Henry Hanson, traveling representative of the Pan American Sanitary Bureau, have been identified by Mr. Komp. Cooperation with the staff of the Rockefeller Foundation in Costa Rica has resulted in the discovery of a new species of *Haemagogus*, a genus of mosquitoes now known to be concerned with the transmission of jungle yellow fever. The description of this species is now in press. The presence of over 80 species of mosquitoes in Costa Rica has been verified during the course of a mosquito and malaria survey of that country now being made by the Rockefeller Foundation, the material being collected and turned over to Mr. Komp for identification. Much interesting material from Venezuela has been identified at the request of the Seccion de Malariologia of the health service of that country. A collection of over 2,000 specimens, collected in areas of endemic yellow fever in Colombia, has been identified at the request of the Rockefeller Foundation workers there.

A paper on the nomenclature of the parts of the mosquito thorax, and the setae they bear, which are useful in classification, has been published. Work on a revision of the Anopheles mosquitoes of the Caribbean region has been continued and has been completed with the exception of the many illustrations. Material has been collected

and a revision of the genus *Haemagogus*, concerned in the transmission of jungle yellow fever, has been begun. This has interfered to a certain extent with the Anopheles monograph but the immediate importance of the *Haemagogus* group seemed to warrant this interruption.

Aedes leucocelaenus, a species closely related to *Haemagogus*, has very recently been incriminated as one of the mosquito vectors of jungle yellow fever in Brazil. This species was described from material collected in Panama. Comparison of the Panama material with authentic specimens from Brazil, British Guiana, and Colombia, shows that the Panama material represents one species and the South American specimens are another, the true *A. leucocelaenus*. A paper describing the Panama species and calling attention to the differences between it and the known vector of yellow fever is now in press.

As a traveling representative of the Pan American Sanitary Bureau, Mr. Komp made a census of the incidence of the larvae of the yellow-fever mosquito, *Aedes aegypti*, in the port of Guayquil, Ecuador, in October and November 1937. A full report has been rendered, an abstract of which is being published.

Lt. James J. Sapero, Medical Corps, United States Navy, has been on tour of duty at the laboratory since July 6, 1937, with two naval laboratory technicians to assist him. Mr. L. E. Boston, chief pharmacist's mate, United States Navy, has completed approximately 2½ years' work at the laboratory and he will return to regular naval duties in August of 1938. Mr. M. H. Williams, pharmacist's mate, first class, United States Navy, will begin work at the laboratory in October of 1938.

The naval unit has continued its work on human intestinal parasites. The survey for intestinal protozoa, commenced in July of 1937, has recently been completed. In collaboration with the laboratory staff more than 1,000 naval men have been examined. This survey has been conducted on men who have been particularly exposed to amebiasis in the highly endemic regions of the Tropics and Asiatics. The results concern the problem of further transmission of the dysentery organism in the Navy, and finally, in the general civilian population of the United States. A second paper on this investigation will concern the relationship of the data to present concepts of transmission of amebiasis.

During the past year a clinical study of the healthy carrier of *Endamoeba histolytica* has been made. These observations are to be extended in the coming year to include a study of the more serious clinical phases of amebiasis, particularly, the aspects of the disease in the absence of dysentery. In this work a correlation with the various races of *E. histolytica* with symptomatology and evidence of pathogenicity will be made.

A report has been sent to press on general and military aspects of the hookworm problem. An examination of 1,169 naval recruits from the southern endemic hookworm centers, showed an incidence of over 20 percent of the men parasitized. A study of the infested men revealed an anemia which appeared to be due to the presence of the hookworms. The high incidence and evidence of harmful effect in apparently healthy individuals emphasized the need for preventive measures in the group. Further studies to determine the intensity levels of the hookworm infestations are being carried on in a comparable group of men in military service in the Canal Zone.

VISITING SCIENTISTS

Dr. George R. Cowgill, from the laboratory of physiological chemistry, Yale University, paid a second visit to the laboratory for a month's study. The primary object of his visits has been to investigate possibilities for research in nutrition as it relates to tropical diets. This report covers what has been accomplished since his first visit as well as progress in field studies during the second visit. During the past year Dr. A. V. Mastellari, of the National Dispensary, Republic of Panama, arranged for his visiting nurse group to collect data on the amount of different foods eaten by various families in the city of Panama. Records pertaining to 18 families have now been filed for study in New Haven. It has been arranged for these studies to be continued and dietary scales have been provided. Gorgas Hospital, Ancon, C. Z., has been recording in the same manner the various foods eaten by seven native patients. These cases were fed what the staff presumes is a satisfactory diet for such patients. These records will be analyzed at Yale. Further records will be collected until the body of data is large enough so that conclusions can be drawn.

As a result of visits in 1937 to the rural villages on the Chagres River near the Santa Rosa Malaria Control Station of the laboratory some ideas were gained as to how quantitative data might be secured concerning the food intake of these natives. It was possible this summer to give personal attention to this particular problem since at the close of the day it was possible to live with comfort and safety at Juan Mina Station. One week was devoted to the villages of Santa Rosa, Guayabalito, and Gatuncillo. Fifteen dietary scales were distributed and the "practical nurse" was shown the method of use and how to make proper use of the dietary form sheets. Only selected families were studied and for a period of only 1 week. As a result of this program 10 satisfactory family records have been obtained in these villages. The same method was placed in effect the next week in New San Juan where five family records were secured. The third week was spent in further instructions for the procurement of additional records in both the *rainy season* and *dry season*. It will be possible to make a reasonably accurate estimate of the value of these respective rural native diets from the viewpoint of their content of protein, minerals, vitamins, etc. Such examinations will, of course, be conducted at Yale. The staff entomologist has expressed the opinion that he can safely supervise the weighing and recording of the work left in the hands of the local nurses since he will be canvassing all houses on his mosquito work. The established relationship of lack of fat-soluble vitamin A to night blindness has been studied sufficiently now to result in a method for recording in objective physical units the sensitivity of the human eye to light, and the effect of vitamin A administration upon that sensitivity. Dr. Cowgill has just secured the instrument needed for such a study and is planning to use it during the academic year at Yale on normal people and on patients. This may be applied next year to the people in the Chagres villages. A portable instrument that can be used on a battery will be ready for next season and could be used at Juan Mina Station on selected groups from the villages. Since his 1937 visit Dr. Cowgill has been consulted by the health officers of Jamaica, Cuba, British Honduras, and Costa Rica. During

the winter holidays of 1937–38 he was a guest of the Cuban Government and gave six lectures on nutrition at the Instituto Finlay. This institute is to establish a nutrition laboratory. A Cuban chemist was sent as a Rockefeller Foundation fellow to Yale to prepare himself for duty in this new unit and he will receive nonresident direction from Yale. School doctors in Jamaica are convinced that some of the conditions encountered in school children are essentially dietary deficiencies. Experiments are desired in simple drinks and food combinations within the reach of such children, such as providing ample amounts of calcium without using milk or milk products. It appears that the laboratory's approach to nutritional studies this and last year need not be viewed as an isolated effort but as part of a larger and what may well develop into a concerted effort on the part of many persons, institutions, and governments in this part of the world.

Dr. S. W. Britton, from the physiological laboratory of the University of Virginia, with an assistant, Mr. R. Klein, spent a short period of time at the laboratory, March 9 to April 2. Observations were made on the adrenal glands and brains of various species of animals, including 18 monkeys, 13 sloths, 3 peccaries, 7 raccoons, 6 crocodiles, and 2 snakes.

Dr. William H. Taliaferro was shipped certain monkeys at Chicago University in order to complete some phases of his study on monkey malaria.

Dr. Marion Hood, associate in medicine from the University of Illinois College of Medicine, came to the laboratory on June 10, 1938, for a 2-month stay. Dr. Hood is parasitologist for the Research and Educational Hospital of the University of Illinois and teaches parasitology. She came to gain some field experience and collect material for use in her work. She became a useful member of the staff and made all regular field trips to the Chagres River villages as well as an expedition into the Province of Darien, where 6 Tuira River villages were surveyed for malaria, filariasis, Chagas' disease, and other surveys pertaining to serological tests. In two surveys made in the Chagres River villages, one by Dr. E. C. Faust in 1930 and the other by Dr. Harry E. Wright in 1937, ova of *Capillaria hepatica* were found in the fecal specimens of 9 and of 16 people, respectively. Dr. Hood was able to find 8 of these positives and reexamine them. All were negative for the parasite in 1938. Dr. Hood was very fortunate in finding a variety of interesting work in the neighboring hospitals and laboratories considering the brevity of her visit.

The Eastern Association of Mosquito Control Workers sent 11 of their officers and members to the Isthmus for a period of observation extending from January 28 to February 8, 1938. They spent some time at the Santa Rosa Station and made thorough studies in the Canal Zone and certain other parts of the Republic of Panama as well.

TRANSIENT SCIENTIFIC VISITORS

Five seafaring and jungle scientific expeditions called at the laboratory to discuss their plans and medical problems. In addition to these visitors there were 42 scientific visitors from various parts of the world. Dr. A. Hoff, who is in charge of tropical medicine and parasitology at Bellevue Hospital, New York, spent 2 weeks in observing work and collecting material.

SNAKE CENSUS

The year's collection of snakes was shipped to the Museum of Comparative Zoology at Harvard. The total catch for the year was 2,128, of which 509 were poisonous snakes, a rate of 23.9 percent. The details are shown in exhibit B.

COOPERATION WITH OTHER ORGANIZATIONS

Close relations have continued with the Republic of Panama, the Panama Canal, United States Public Health Service, United States Navy, and United States Army Medical Research Board. Beneficial contacts have been maintained with the United Fruit Co. and its tropical units.

A new and important cooperation between the Gorgas Memorial Laboratory and the University of Pennsylvania became effective on June 1, 1938. The director of the laboratory will serve as consulting director of the School of Animal Pathology, a new experimental unit of the university located on the Bolton farm about 30 miles from Philadelphia and next to the Wistar farm (a part of Wistar Institute). He will spend some time each spring and fall at this new school and in close cooperation with the veterinary school of the university.

The director of the Gorgas Memorial Laboratory made another survey of thoroughbred horse centers in Kentucky, Virginia, Ohio, and Pennsylvania at the request of Admiral Grayson and the National Horse and Mule Association. It seems almost certain, now, that some permanent centers for research on domestic animal diseases will be in operation.

Valuable cooperation is still given us by Dr. Thomas Barbour, director of the Museum of Comparative Zoology at Havard and Dr. E. R. Dunn of Haverford College. Pleasant relations continue with Barro Island Research Station in Gatun Lake, Canal Zone, and with the Bureau of Animal Industry and Smithsonian Institution. Important relations exist with the representatives of the Rockefeller Foundation in Central and South America.

The laboratory staff has acted in a medical advisory capacity with local ranch and plantation owners as well as a new timber company.

The Medical Association of the Isthmian Canal Zone and the National Medical Association of the Republic of Panama hold the majority of their meetings in the laboratory auditorium. The Panama Canal Natural History Society held 12 of its meetings in the auditorium. Many of their lectures are on medical or allied biological subjects. Lectures on natural history and snakes have been given the local Boy Scout organizations, the Army, Navy, Young Men's Christian Association, and junior college classes of biology. Two stated medical meetings have been addressed by visiting surgeons.

PERSONNEL

Staff.—Director, protozoologist (and assistant director), helminthologist, medical entomologist.

Technical staff.—Chief technician, assistant chief technician, four assistant technicians.

Office and other staff.—Clerk, librarian (and assistant clerk), auditor (part time), janitress, chauffeur, three animal handlers, yardman, night watchman.

Santa Rosa Station.—River supervisor (and motorboat operator), six community nurses.

Miraflores Veterinary Station.—Foreman, foreman's assistant (and motorboat operator), helper.

Total number employed, 30.

PERSONNEL ON TOUR OF DUTY

W. H. W. Komp, medical entomologist, United States Public Health Service.

Lt. James J. Sapero (Medical Corps), United States Navy.

L. E. Boston, chief pharmacist's mate, first class, United States Navy.

PUBLICATIONS

A list of 15 articles and reports prepared for publication is attached to this report as exhibit A.

REPORT OF RECEIPTS AND DISBURSEMENTS

A report of receipts and disbursements for the period from July 1, 1937, to June 30, 1938, is attached hereto as exhibit C.

Respectfully,

GEORGE CRILE, M. D.,
President.

HERBERT C. CLARK, M. D.,
Director, Gorgas Memorial Laboratory.

EXHIBIT A

PUBLICATIONS LISTED DURING THE YEAR 1937–38

Entomology

The Role of Some Common Anopheline Mosquitoes of Panama in the Transmission of Malaria. Lloyd E. Rozeboom. Amer. Jour. Trop. Med., 1938, 18:3:289–302.

A New Species of *Haemagogus* from Costa Rica, and a Description of the Larva of *Haemagogus anastasionis* Dyar. (Diptera Culicidae.) W. H. W. Komp and H. W. Kumm. Proc. Ent. Soc. Wash., in press.

Aedes leucotaeniatus, a New Species of *Aedes* Allied to *A. leucocelaenus* D. & S., and Descriptions of the Male and Larva of *A. leucocelaenus* D. & S. W. H. W. Komp. Proc. Ent. Soc. Wash., in press.

Censo Estegomico (Aedico) en Quayaquil. W. H. W. Komp. Boletin Oficina Sanitaria Pan Americana, 1938, 17:7:619–620.

On the Comparative Susceptibility of Certain Species of Neartic and Neotropical Anophelines to Certain Strains of *Plasmodium vivax* and *P. falciparum* from the Same Regions. Mark F. Boyd, Henry P. Carr, and Lloyd E. Rozeboom. In press.

Protozoology

Incidence of *Endamoeba histolytica* and Other Intestinal Parasites in Variously Exposed Groups of the Navy. J. J. Sapero and C. M. Johnson. In press.

An Eighth Year's Observations on Malaria in Panama. H. C. Clark and W. H. W. Komp. Amer. Jour. Trop. Med. In press.

Helminthology

The Occurrence of *Trichostrongylus axei* (Cobbold) in Equines of Panama. A. O. Foster. Jour. Parasit., 1937, 23:6:573–574.

Notes on Parasites of Horses in Hawaii. A. O. Foster and J. E. Alicata. Proc. Helminth. Soc. Wash., January 1939, in press.

Some Helminths of the Woolly Opossum in Panama. A. O. Foster. Trans. Amer. Micro. Soc., in press.

A Preliminary Note on the Identity, Life-cycle and Pathogenicity of an Important Nematode Parasite of Captive Monkeys. A. O. Foster and C. M. Johnson. In press.

Some General and Military Aspects of the Hookworm Problem. J. J. Sapero. In press.

Miscellaneous

Review of Recent Research on Drug Prophylaxis and Treatment of Malaria. H. C. Clark. (A member's report to the Chairman of the Subcommittee on Medical Research of the National Malaria Committee for 1938.) In press.

Periodic Ophthalmia or Moonblindness. A Survey Conducted in April and May 1938. H. C. Clark. (Report rendered to the President of the Gorgas Memorial Institute, Bureau of Animal Industry, National Horse and Mule Association of America, Thoroughbred Association of America and four experimental centers.)

Progress Report on the Snake Census of Panama, 1937–38. H. C. Clark. (A report rendered the Museum of Comparative Zoology at Harvard College.) Exhibit B of the 1937–38 report of the Gorgas Memorial Laboratory.

PUBLICATION REFERENCES FOR ARTICLES LISTED IN LAST YEAR'S REPORT AS "IN PRESS"

The Nomenclature of the Thoracic Sclerites in the Culicidae and their Setae. W. H. W. Komp. Proc. Ent. Soc. Wash., 1937, 39:9:241–252.

The Eggs of the *Nyssorhyncus* Group of *Anopheles* (Culicidae) in Panama. Lloyd E. Rozeboom. Amer. Jour. Hygiene, 1938, 27:1:95–107.

On the Effectiveness of Carbarsone as a Remedy for Amoebiasis. E. G. Hakansson. Amer. Jour. Trop. Med., 1938, 18:3:245–269.

A Seventh Year's Report on Malaria in Panama (Chagres Valley) with Reference to Drug Control. H. C. Clark and W. H. W. Komp. Amer. Jour. Trop. Med., 1938, 18:3:271–288.

Cardiac Changes in Dogs Experimentally Infected with *Trypanosoma cruzi*. C. M. Johnson. Amer. Jour. Med., 1938, 18:2:197–206.

Further Observations on the Incidence of *Hepaticola hepatica* Ova in Human Feces. Harry E. Wright. Amer. Jour. Trop. Med., 1938, 18:3:329–330.

A Review of Recent Research on Medical Prophylaxis and Treatment of Malaria. H. C. Clark. Sou. Med. Jour., 1938, 31:8:933–938.

The Development of International Transportation and its Effect on the Practice of Tropical Medicine. H. C. Clark. Amer. Jour. Trop. Med., 1938, 18:1:1–7.

A New Method for the Stripping of Venomous Snakes. C. M. Johnson. Amer. Jour. Trop. Med., 1938, 18:4:385–386.

EXHIBIT B

PROGRESS REPORT ON SNAKE CENSUS OF PANAMA

(By Gorgas Memorial Laboratory and the Museum of Comparative Zoology at Harvard)

The general notes on this subject can be obtained by reference to exhibit B of our 1936 and 1937 reports. No effort will be made to increase the collection of snakes from those areas where 1,000 or more specimens have been secured from the lowlands. The tablelands and mountains are still open to collection but so few people reside there that we do not anticipate large collections. It is still desired to add to our knowledge from the lowlands of the Atlantic coast.

The following species of poison snakes are represented in this census:

Fer de lance—*Bothrops atrox.*

Hog nosed vipers—*Bothrops lansbergii*
and *Bothrops nasutus.*

Tree vipers—(*a*) *Bothrops schlegelii*,
(*b*) *Bothrops lateralis* and
(*c*) *Bothrops nigroviridis nigroviridis*.
One specimen of (*b*) and of (*c*) captured thus far.
Mano de piedra or timbo—*Bothrops nummifiera*. One specimen caught last year at Mina de Cana, Darien. It was counted in with the hog-nosed vipers.
Bushmaster—*Lachesis mutus*.
Coral—*Micrurus nigrocinctus nigrocinctus*.
Micrurus mipartitis.
Micrurus dunni.
Micrurus clarki.
Sea serpent—*Hydrus platurus*.

TABLE I.—*Poison-snake incidence, by locations*

[Snake census from Sept. 18, 1937, to Sept. 10, 1938]

Locations	Total catch	Poison snakes	Percent poison snakes
Rio Tuira—Mina de Cana	136	45	33.1
Rio Chagres—Midbasin	357	94	26.3
Panama, Chepo, Sabanas	1,628	363	22.3
Chiriqui Province plantations	7	7	100.0
Total	2,128	509	23.9

TABLE II.—*Poison snakes (509) by species and locations*

[Snake census from Sept. 18, 1937, to Sept. 10, 1938]

Species	Rio Tuira Mina de Cana	Rio Chagres	Panama Chepo Sabanas	Chiriqui plantations	Total
Hog-nosed viper	3	19	221	0	243
Fer de lance	32	29	33	7	101
Coral	5	33	106	0	144
Bushmaster	5	11	1	0	17
Horned-palm viper	0	2	2	0	4
Total	45	94	363	7	509

TABLE III.—*Cumulative snake census January 1929 to September 1938*

Location	Total catch	Poison snakes	Percent poison snakes
Rio Tuira, Darien Province	3,475	851	24.5
Rio Chagres, Colon and Panama Provinces	1,476	331	22.4
Rio Santa Maria, Cocle, Herrera Provinces	340	83	24.4
Rio Concepcion, Veraguas Province	17	6	35.3
Panama, Chepo, Sabanas	3,018	798	26.4
Chiriqui, Coiba, etc	194	95	48.9
Total	8,520	2,164	25.4

TABLE IV.—*Cumulative snake census January 1929 to September 1938, poison snakes (2,164), by species and locations*

Species	Rio Tuira	Rio Chagres	Rio Santa Maria	Rio Concepcion	Panama Chepo Sabanas	Miscellaneous places	Total	Percent species
Fer de lance	715	72	0	0	60	73	920	42.5
Hog-nosed viper	55	46	83	0	513	2	699	32.3
Tree bush viper	3	67	0	1	4	9	84	3.9
Coral	45	108	0	3	216	8	380	17.5
Bushmaster	33	38	0	2	2	2	77	3.6
Sea serpent	0	0	0	0	3	1	4	.18
Total	851	331	83	6	798	95	2,164	

TABLE V.—*General incidence of poison species*

[Cumulative snake census, January 1929 to September 1938]

Poison species	Total catch	Total number specimens	Percent poison species
Fer de lance	8,520	920	10.8
Hog-nosed viper	8,520	699	8.2
Tree and bush viper	8,520	84	.98
Coral	8,520	380	4.4
Bushmaster	8,520	77	.90
Sea serpent	8,520	4	.04
Total	8,520	2,164	25.4

EXHIBIT C

GORGAS MEMORIAL INSTITUTE, LABORATORY ACCOUNT

Statement of cash receipts and disbursements July 1, 1937, to June 30, 1938

CASH RECEIPTS

Contribution by U. S. Government	$50,000.00
Interest received on bank deposits	30.14
Interest received on endowment fund investments	57.87
Miscellaneous sales and services	590.21
Total, cash receipts	50,678.22

CASH DISBURSEMENTS

Equipment:		
Laboratory apparatus	$28.03	
Furniture and fixtures	71.07	
Library	411.38	
		$510.48
Salaries, Washington office		1,200.00
Other expenses, Washington office		837.85
Salaries, Panama laboratory		30,603.00
Travel allowances		865.46
Maintenance of buildings		892.63
Operation and maintenance of equipment		633.82
Publications and reprints, Panama		883.17
Other expenses, Panama		1,723.69
Miraflores outstation, veterinary		2,062.32
Santa Rosa outstation, malaria control		1,847.88

Statement of cash receipts and disbursements July 1, 1937, to June 30, 1938—Continued

CASH DISBURSEMENTS—continued

Other outstations and projects	$990. 47
Materials and supplies	2, 160. 44
Laboratory animals, purchase and upkeep	1, 809. 32
Total, cash disbursements	47, 020. 53
Excess of cash receipts over disbursements	3, 657. 69
Balance on cash on deposit June 30, 1937	10, 351. 79
Balance cash on deposit, June 30, 1938	14, 009. 48
Riggs National Bank:	
Checking account	1, 312. 18
Equipment replacement account	7, 444. 12
Chase National Bank, Panama:	
Checking account	4, 799. 67
Savings account	341. 43
The Panama Canal, security deposits	112. 08
	14, 009. 48